

**NSTAR Diagnostic Package (NDP) Architecture
and Deep Space One (DS1) Spacecraft Event detection**

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ABSTRACT

The Deep Space One (DS1) mission is in the process of demonstrating the long duration use of an Ion Propulsion Subsystem (IPS). The NASA SEP Technology Applications Readiness (NSTAR) Project developed the NSTAR Diagnostics Package (NDP) to monitor the spacecraft environment due to the IPS. The NDP measures contamination, plasma characteristics, electrical fields and magnetic fields. The selection of the sensors was based on the results of an IPS diagnostics workshop and an industry users/manufacturers survey. The NDP consists of nine sensors, sensor conditioning circuitry and two computers to collect and process the data. The sensor suite consists of two quartz crystal microbalances (QCM), two optical solar reflector calorimeters, two Langmuir probes, one Retarding Potential Analyzer (RPA), a 2-meter dipole Plasma Wave Antenna (PWA) and pre-amplifier, single-axis miniaturized search coil (SC0) and a pair of tri-axial flux gate magnetometers (FGM 0 & 1). The NDP can be considered as two separate computer/sensor systems, the Diagnostics Sensors Electronics Unit (DSEU) and the Fields Measurement Processor (FMP).

The DSEU communicates with the spacecraft and the FMP. The DSEU performs signal conditioning and data formatting for the QCMs, calorimeters, Langmuir probes and RPA. The DSEU samples the sensor data once every two seconds and provides the data to the spacecraft in specific Mil-Std-1553 sub-addresses. The DSEU receives spacecraft time and keeps a running clock to time-tag the data. The DSEU periodically receives data from the FMP via an RS-232 bi-directional serial port.

The FMP performs signal conditioning and signal processing for the PWA and SC0. The FMP collects FGM data from the FGM electronics package. The FMP collects two types of PWA and SC0 data. Every 16 seconds the FMP collects scan spectrometer data and sporadically provides "Burst" time domain data. The PWA scan data is spectral data over six and a half decades, 10hz - 40Mhz, four bands (a.k.a channels) per decade. The SC0 scan data is spectral data over four decades, 10hz - 100Khz, four bands per decade. The PWA/SC0 Burst data are 20,000 samples of time domain data collected at 20,000 samples a second. The scan FGM data is sixteen sets of data. Each set is the average of 20 samples in a one-second interval. The Burst FGM data is a collection of the FGM data sampled at 20 samples a second.

Though the NDP was designed to measure the effects of the IPS on the spacecraft, the NDP has also been used to monitor and diagnose spacecraft functions and anomalies. NDP detects hydrazine thruster firings (planned and not planned), ion engine gimbal stepper motor currents, solar array currents, spacecraft charging, as well as a number of other phenomena. Examples of selected spacecraft signatures and their interpretations are discussed.